

CLAIMS

1. A thermal processing unit comprising:
 - a heating-furnace body whose upper end has an opening,
 - a reaction tube consisting of a single tube contained in the heating-furnace body,
 - a gas-discharging-unit connecting portion formed at an upper portion of the reaction tube, the gas-discharging-unit connecting portion having a narrow diameter,
 - a substrate-to-be-processed supporting member for supporting a substrate to be processed, contained in the heating-furnace body, and
 - a heating unit for heating the substrate to be processed supported by the substrate-to-be-processed supporting member, wherein the heating unit has:
 - a first heating portion arranged around the reaction tube,
 - a second heating portion arranged around the gas-discharging-unit connecting portion,
 - a third heating portion arranged around an upper portion of the reaction tube,
 - a fourth heating portion arranged around a lower portion of the reaction tube, and
 - a fifth heating portion arranged under the substrate-to-be-processed supporting member.
2. A thermal processing unit according to claim 1, wherein the first heating portion is formed by a plurality of linear heat-generating members, which are arranged in parallel with a longitudinal direction of the reaction tube.
3. A thermal processing unit according to claim 1, wherein the first heating portion is formed by a plurality of U-shaped heat-generating members, which are arranged in parallel with a longitudinal direction of the reaction tube.
4. A thermal processing unit according to any of claims 1 to 3, wherein

the second heating portion is formed by a linear heat-generating member, which is arranged in a spiral pattern.

5. A thermal processing unit according to any of claims 1 to 4, wherein

the third heating portion is formed by a linear heat-generating member, which is arranged in a spiral pattern.

6. A thermal processing unit according to any of claims 1 to 4, wherein

the third heating portion is formed by a linear heat-generating member, which is arranged in a switchback pattern.

7. A thermal processing unit according to any of claims 1 to 6, wherein

the fourth heating portion is formed by a linear heat-generating member, which is arranged in a spiral pattern that is seen as a rectangular in a circumferential direction of the reaction tube.

8. A thermal processing unit according to any of claims 1 to 6, wherein

the fourth heating portion is formed by a linear heat-generating member, which is arranged in a switchback pattern.

9. A thermal processing unit according to any of claims 1 to 8, wherein

the fifth heating portion is formed by a plate-like heat-generating member.

10. A thermal processing unit according to any of claims 1 to 8, wherein

the fifth heating portion is formed by a heat-generating member arranged along a lower surface of the substrate-to-be-processed supporting member.

11. A thermal processing unit according to any of claims 2 to 4 and 8,

wherein

the linear heat-generating member is formed by sealing a resistance heater into a hollow tubular member made of ceramics.

12. A thermal processing unit according to claim 9, wherein
the plate-like heat-generating member is formed by sealing a resistance heater into a hollow plate-like member made of ceramics.

13. A thermal processing unit according to claim 11 or 12, wherein
the ceramics is quartz.

14. A thermal processing unit according to any of claims 1 to 13,
wherein
the second heating portion is supported in a movable manner in a horizontal direction.

15. (Canceled)

16. (Canceled)

17. (Canceled)

18. (Canceled)

19. (Canceled)

20. (Canceled)

21. (Canceled)

22. (Canceled)

23. (Canceled)

24. (Canceled)

25. (Canceled)

26. (Canceled)

27. (Amended) A thermal processing unit comprising:

- a heating-furnace body whose upper end has an opening,
- a reaction tube consisting of a single tube contained in the heating-furnace body,
- a gas-discharging-unit connecting portion formed at an upper portion of the reaction tube, the gas-discharging-unit connecting portion having a narrow diameter,
- a substrate-to-be-processed supporting member for supporting a substrate to be processed, contained in the heating-furnace body,
- a heating unit for heating the substrate to be processed supported by the substrate-to-be-processed supporting member,
- a reaction-tube lower lid that seals a lower portion of the reaction tube and holds airtightness in the reaction tube, and
- a temperature measuring unit formed by sealing a plurality of temperature measuring members into a hollow tubular member, wherein the hollow tubular member is arranged in a gap between the heating-furnace body and the reaction tube.

28. A thermal processing unit comprising:

- a heating-furnace body whose upper end has an opening,
- a reaction tube consisting of a single tube contained in the heating-furnace body,
- a gas-discharging-unit connecting portion formed at an upper portion of the reaction tube, the gas-discharging-unit connecting portion having a narrow diameter,
- a substrate-to-be-processed supporting member for supporting a substrate to be processed, contained in the heating-furnace body,
- a heating unit for heating the substrate to be processed supported by the substrate-to-be-processed supporting member,
- a reaction-tube lower lid that seals a lower portion of the reaction tube and holds airtightness in the reaction tube,
- a first temperature measuring unit formed by sealing a plurality

of temperature measuring members into a first hollow tubular member,
a second temperature measuring unit formed by sealing a plurality of temperature measuring members into a second hollow tubular member, and

a third temperature measuring unit formed by sealing a plurality of temperature measuring members into a third hollow tubular member,
wherein at least a portion of the first hollow tubular member extends horizontally from a middle portion of the reaction tube in a longitudinal direction,

at least a portion of the second hollow tubular member extends horizontally from an upper portion of the reaction tube, and

at least a portion of the third hollow tubular member is arranged in a gap between the heating-furnace body and the reaction tube.

29. A thermal processing unit comprising:

a heating-furnace body whose upper end has an opening,

a reaction tube consisting of a single tube contained in the heating-furnace body,

a gas-discharging-unit connecting portion formed at an upper portion of the reaction tube, the gas-discharging-unit connecting portion having a narrow diameter,

a substrate-to-be-processed supporting member for supporting a substrate to be processed, contained in the heating-furnace body,

a heating unit for heating the substrate to be processed supported by the substrate-to-be-processed supporting member,

a reaction-tube lower lid that seals a lower portion of the reaction tube and holds airtightness in the reaction tube,

a second temperature measuring unit formed by sealing a plurality of temperature measuring members into a second hollow tubular member, and

a third temperature measuring unit formed by sealing a plurality of temperature measuring members into a third hollow tubular member,

wherein at least a portion of the second hollow tubular member extends horizontally from an upper portion of the reaction tube, and

at least a portion of the third hollow tubular member is arranged in a gap between the heating-furnace body and the reaction tube.

30. (Canceled)

31. A thermal processing unit comprising:

- a heating-furnace body whose upper end has an opening,
- a reaction tube consisting of a single tube contained in the heating-furnace body,

- a gas-discharging-unit connecting portion formed at an upper portion of the reaction tube, the gas-discharging-unit connecting portion having a narrow diameter,

- a substrate-to-be-processed supporting member for supporting a substrate to be processed, contained in the heating-furnace body,

- a heating unit for heating the substrate to be processed supported by the substrate-to-be-processed supporting member,

- a reaction-tube lower lid that seals a lower portion of the reaction tube and holds airtightness in the reaction tube,

- a second temperature measuring unit formed by sealing a plurality of temperature measuring members into a second hollow tubular member, and

- a third temperature measuring unit formed by sealing a plurality of temperature measuring members into a third hollow tubular member,

- wherein the heating unit has:

- a first heating portion arranged around the reaction tube,

- a second heating portion arranged around the gas-discharging-unit connecting portion,

- a third heating portion arranged around an upper portion of the reaction tube,

- a fourth heating portion arranged around a lower portion of the reaction tube, and

- a fifth heating portion arranged under the substrate-to-be-processed supporting member,

- at least a portion of the second hollow tubular member extends horizontally from an upper portion of the reaction tube, and

- at least a portion of the third hollow tubular member is arranged in a gap between the heating-furnace body and the reaction tube.

32. A thermal processing unit comprising:
- a heating-furnace body whose upper end has an opening,
 - a reaction tube consisting of a single tube contained in the heating-furnace body,
 - a gas-discharging-unit connecting portion formed at an upper portion of the reaction tube, the gas-discharging-unit connecting portion having a narrow diameter,
 - a substrate-to-be-processed supporting member for supporting a substrate to be processed, contained in the heating-furnace body,
 - a heating unit for heating the substrate to be processed supported by the substrate-to-be-processed supporting member,
 - a reaction-tube lower lid that seals a lower portion of the reaction tube and holds airtightness in the reaction tube,
 - a first temperature measuring unit formed by sealing a plurality of temperature measuring members into a first hollow tubular member,
 - a second temperature measuring unit formed by sealing a plurality of temperature measuring members into a second hollow tubular member, and
 - a third temperature measuring unit formed by sealing a plurality of temperature measuring members into a third hollow tubular member,
- wherein the heating unit has:
- a first heating portion arranged around the reaction tube,
 - a second heating portion arranged around the gas-discharging-unit connecting portion,
 - a third heating portion arranged around an upper portion of the reaction tube,
 - a fourth heating portion arranged around a lower portion of the reaction tube, and
 - a fifth heating portion arranged under the substrate-to-be-processed supporting member,
- at least a portion of the first hollow tubular member extends horizontally from a middle portion of the reaction tube in a longitudinal direction,
 - at least a portion of the second hollow tubular member extends horizontally from an upper portion of the reaction tube, and
 - at least a portion of the third hollow tubular member is arranged

in a gap between the heating-furnace body and the reaction tube.

33. A thermal processing unit according to claim 31 or 32, wherein a temperature controlling unit is provided around the gas-discharging-unit connecting portion.
34. A thermal processing unit according to claim 33, wherein the temperature controlling unit is a heat-insulating material.
35. A thermal processing unit according to claim 33, wherein the temperature controlling unit is a resistance heater.
36. A thermal processing unit according to claim 34 or 35, wherein the temperature controlling unit has flexibility.
37. A thermal processing unit according to claim 34 or 35, wherein the temperature controlling unit is shaped in advance.
38. A thermal processing unit according to any of claims 31 to 37, wherein
the gas-discharging unit is a gas-discharging pipe whose end portion has a flange,
a flange is formed at an end portion of the gas-discharging-unit connecting portion, and
the flange at the end portion of the gas-discharging-unit connecting portion and the flange at the end portion of the gas-discharging pipe are hermetically connected to each other by means of a sealing unit.
39. A thermal processing unit according to claim 38, wherein the temperature controlling unit has a fluid hole provided in the flange.